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## GEOGRAPHY OF THE SZECHWAN SALT INDUSTRY

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### A. History and Administration of the Salt Industry

The history of the salt industry began about 250 BC when Li Pin observed and enlarged salt springs in the vicinity of what is now Ch'eng-tu. A sizable industry sprung up, reaching its peak in the T'ang Dynasty (600-900 AD). At that time production was found in 64 counties. The government monopoly on salt was introduced at this time.

Severe taxation under the Yuan Dynasty caused the industry to languish, but it revived considerably under the Ming. The troubled years of the Manchu conquest brought about another depression from which the industry only gradually recovered.

In the 19th Century the salt-producing region was divided into 24 districts for taxation purposes. Later in that century the discovery of natural gas and the cutting off of sea-water salt due to internal disorders, gave new impetus to the enterprises in Szechwan.

The administration of the salt monopoly under the Republic follows the pattern of that under the Empire with minor changes. There are 24 districts in Szechwan, divided into three circuits, under one provincial office. Various methods of taxing, rationing and licensing have been employed through the centuries of government control.

Taxation on Szechwan salt has now been unified, with 14 rate classifications on a graduated scale. In 1938 the total revenue was more than 33,970,000 yuan, a figure that has since increased due to greater production and inflation.



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This revenue is no small factor in government finance.

B. Manufacture of Salt in Szechwan

Szechwan has rich resources of many types of salt because the region was a marine bed in the Triassic period, and the salt deposits were formed by the drying up of the sea. Because of varying conditions of deposition, pure saline deposits became rock salt, and weak solutions became saline mud, which in subterranean solution became brine, that is, white brine; white brine, becoming contaminated with sulfur compounds, became black brine.

In the Cretaceous period the saline materials in the strata surrounding the basin were, under weathering, dissolved in surface or underground streams and collected as small grains of salt in the red strata in the central portion of the basin. These were again dissolved by underground streams and became yellow brine.

Thus, Szechwan salt may be classified under the five types: rock salt, white brine, black brine, yellow brine, and mixed brine. All these are deep below the surface. The deeper types are 1,000 meters down, the shallower, several score meters. In general, yellow brine is 200 to 500 meters deep; the other types, 700 to 1,000 meters deep.

1. Extraction of Brine

a. Drilling wells

Primitive methods are still used. When a spot has been selected, a good-sized opening is made in which a hollow stone cylinder is placed, the hollow portion being a foot or more in diameter. As the hole is deepened, several of these hollow cylinders are inserted in succession, to prevent the sides from caving in and the surface water from flowing in. Then a wooden frame is built over the aperture, from which is suspended a drill shaped like a fish tail or horse hoof, as occasion requires. The drill is worked with a treadle by human labor, and the debris removed by means of a scoop or bucket. After the water-bearing beds have been passed, and the hard strata appear, a new type of drill is substituted. This is made by hollowing out two hardwood slabs, then putting them together to form a long tube, whose diameter is that of the well's bore. The tube is tightly sealed by means of tung oil, lime, coarse linen, and twine. It is then suspended in the well from a windlass, and a smaller drill the size of the tube, substituted. This drilling of a smaller bore continues until the brine is reached. The smaller bore is usually 2 to 5 inches in diameter; those for rock salt are larger, about 6 to 8 inches. Ordinarily, the drilling of a well requires 1 or 2 years; if limestone or hard rock is encountered, progress is slower; but if these strata are thin or gravelly, the delay is not so great.

b. Drawing Up the Brine

If rock salt is found, water is poured in, so the salt is brought out in solution. Two methods are used for the removal of brine, the old and the new. The old method uses human or animal labor, the former in the shallower wells. A bamboo tube or wooden bucket is let down with a rope and the brine hauled up in it, by hand or windlass. In the case of deeper wells, a bamboo tube with valves opening inward is lowered and, when full, drawn up by several oxen drawing a rope over a large wheel. The new method is steam-powered, using machinery with copper cables and steel buckets. A load of brine in the bamboo tubes will weigh 400-500 catties /one catty equals one and one-third pounds/, while the larger steel buckets will contain more than 1,200 catties at a time.

c. Transport of the Brine

From vats at the mouth of the well, the brine is transported to

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the furnaces by coolie labor, or pack animals, or through pipes; the third method is used for conveyance to the more distant boilers.

2. Refining

Because natural brine contains many impurities, it must be refined before being fit for human consumption. Three methods are used, with varying details of technical process, which have grown out of trial-and-error experience. In general, impurities are precipitated by means of bean juice, the brine is either warmed slowly, or boiled, and flakes of pure salt skimmed off the surface. The resulting products, coming by various steps and stages, are pure salt, crude salt, and cakes in which both are found side by side. As a rule 20,000 catties of brine make 1,000 catties of pure salt. After these products are removed, there remains a concentrated mother liquor, sometimes called bitterns. This is used as fertilizer, or in the manufacture of bean curd, or as a whitewashing aid. It has often been discarded. However, during the war a study of this by-product revealed the presence of potassium, magnesium, calcium, bromimum, and other elements, which could be used in the making of many useful chemicals

There is now one plant [elsewhere the author says six] in Tzu-kung to exploit this by-product. If similar plants could be set up at the larger salt works, chemical and defense industries would grow and the salt business in Szechwan would get greater returns.

The production of salt varies from year to year, and there are seasonal variations within each year; in general, production is largest in winter, and least in summer, for the following reasons:

a. Rains, more frequent in summer, dilute the brine, so that processing requires more time and fuel.

b. Efficiency of workers is less in summer due to the heat.

c. Villagers who work in the salt mines when farm work is slack, are drawn back to the farms during the busy season.

d. There is more demand for salted food, and hence for salt, in winter.

C. Influence of the Salt Industry

1. Salt Industry and Labor

Each salt area employs a large number of workers concerned with production and transport. The former include drillers, carpenters, masons, etc., ranging from one to 50 per well; firemen, boilers, kettle repairers, etc., averaging five men to a pair of stoves; pipe men and brine carriers, usually some 20-odd men to a pipe. Transport workers include carriers, drivers, boatmen, etc., in large numbers.

The Yu-Yung area is said to number over 200,000 workers of all types, and the entire industry, half a million. Such a large number could not come from the local population, except as farmers working in slack seasons. A large proportion are local landless peasants and migrants brought by economic stress. This heterogeneous population poses problems of adjustment and social order.

Labor in the salt fields is organized on two schedules, piecework and time-work. Skilled boilers are usually paid by the hour, drillers and brine drawers by the amount. Food is provided by the employers, in addition to wages. The wages are determined by local living standards, the ordinary price of labor being one sheng [about a pint] of rice for 4 hours' work. Most of

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the laborers are men; women and children merely pick over the cinders. Salt workers toil all day in very wet and dirty places by the wells and furnaces, where disease is readily contracted. Eighty or 90 percent use opium to sustain their nerves, thus adding to the wretchedness of their lives and their economic burdens. The larger works have in many cases set up recreational facilities to better the living conditions. There are reading classes for learning to read, and schools for the workers' children.

2. Salt Industry and Trade

Materials needed for salt manufacture include:

a. Implements and Materials

Each well needs annually thousands of drills, buckets, scoops, bands, steel ropes, engine parts, and kettles (a kettle can only be used 350 times for boiling brine). Bamboo is in large demand for tubes, pipes, baskets, etc. Also needed are, tung oil, twine, and soybeans for precipitating impurities (three-tenths of a pint are needed for every 100 catties of salt). Large amounts of brick, lumber, and stone are also needed.

b. Food

Wherever the salt industry prospers, people leave farming for other business; the population grows while the food supply diminishes; grain has to be imported.

c. Fuel

Four kinds of fuel are used in Szechwan for making salt: natural gas, coal, wood, and grass or brush. Of these, gas is the most valuable. One gas well can serve several hundred kettles, or production can be lowered to keep just one or two kettles going. Next in value is coal, which is found in eastern, southern, and western Szechwan. The value of the coal used is about one-third the value of the salt produced. The use of wood for fuel is not economical at all. Grass and brush has little caloric value, and their use is wasteful.

d. Miscellaneous

All the iron tools are manufactured locally, except for some steel rope and kettles; so iron prospers along with salt. Bamboo, wood, and stone are also local products. Some of the tung oil and food is produced where consumed, and the remainder is brought in from elsewhere. Gas comes from "captive" wells, coal is delivered from nearby mines, wood and brush from the hillsides. Consumer goods are found in variety and quantity. All kinds of trade flourish, and some towns in the salt fields have become hundred-day markets due to the abundance of business.

3. Salt Industry and Agriculture

Wherever the salt industry flourishes, there is a corresponding decline in agriculture, for the following reasons:

a. Salt manufacture requires a large labor supply, which it draws in part from the countryside. Where the soil is poor, men leave farming to make salt. This is most noticeable in north Szechwan.

b. In the vicinity of the salt works, some brine escapes into the soil, affecting it unfavorably for the growth of crops.

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c. Where coal is lacking, forests are cut down for fuel. This denuding of the hillsides causes erosion and deterioration of farm lands.

4. Salt Industry and Transportation

The relation here is that of cause and effect. Each interest is vitally affected by the status of the other. The salt business needs good communications for the marketing of its products and the supply of materials. It has therefore taken an active part in developing highways and cart roads, the opening of canals, and the deepening of rivers.

D. Distribution of the Salt Industry

Szechwan wells vary widely as to locality, production, and prosperity. They are described below under five regions, with reference to location, content, production, and 1943 volume of sales.

1. Fu-Yung Region

This region includes the Kung-ching field in Yung County and the Tzu-liu-ching field in Fu-shun Countr, in south central Szechwan. There are 48 rock-salt wells, about 1,000 meters deep; 74 black brine wells, somewhat shallower, with a salinity of 16-24 degrees Baume; 20 yellow brine wells, still shallower, with a salinity of 10 degrees Baume.

There are 470 gas wells. Electric or steam power is used for drawing, and gas for heating. The annual production is 4,800,000 piculs /one picul equals about 133 pounds/.

The sales orbit of this region is extensive, covering a large part of the province, most of Kweichow, and the western parts of Hupeh and Hunan. Transport is mainly by water, but trucks and carts, packs and coolies are also used. Sales in 1943 amounted to 4,596,070 piculs.

Production of salt from this region accounts for one half of the sales and taxes of the province. The quality is good, making it popular and easily salable. Since gas is plentiful, and costs are kept down, the field is profitable. However, three fifths of the product comes from rock salt, and three fourths of this supply has been taken out; it is estimated that known reserves will last only 10 years more. Gas reserves are diminishing too, so the long-range prospects are not bright.

2. North Szechwan Region

In the northern part of the province the fields are contiguous in the same geologic formation and cover some 30,000 sq km. The wells here contain yellow brine, are shallow, and are easily drilled. An astonishing number, something over 110,000, have been opened, of which 86,000 produce brine. Primitive methods are employed, and the brine carried, not piped. Since salinity is low and there are many impurities, the brine is concentrated before being processed, and foreign matter strained out. Fuel used is mostly wood and grass; even arable land is allowed to grow grass and brush for the furnaces. The annual production is 2,274,000 piculs.

Marketing from this region covers a good part of the northern half of this province, and extends into Shensi and Kansu. Sales in 1943 were 2.160,919 piculs.

Despite considerable production, the economic value of the industry in this region is small, due to a chain of unfavorable conditions and no large-scale effort to overcome them.

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3. Lo-shan and Chien-wei Region

This region lies on the Min Ho, west of the Fu-Yung region. At present yellow brine with a salinity of about 10 degrees Baume, is taken from a depth of 200-300 meters. Already 5,554 wells have been drilled. Modern methods are used in a few places, but mostly crude, wasteful ways are followed. Fuel used is coal, obtained from nearby mines. Annual production is 1,240,000 piculs.

The sales territory is large, embracing 45 counties in Szechwan, besides wide stretches in Sikang, Yunnan, Kweichow, and Hupeh. Transport is mainly by the Min Ho and Ch'ang Chiang (Yangtze), and to a lesser extent by road. Sales in 1943 totaled 1,237,572 piculs.

This region is still largely unexploited. Black brine, petroleum, and gas have been discovered, but not exploited. The proximity of coal fields assures a supply of fuel for salt manufacture. All told, this region with plenty of essential resources and easy transportation has a high economic value.

4. East Szechwan Region

These wells, with a few exceptions, have white brine from limestone beds, with a minimum of impurities. Brine-bearing strata, folded and near the surface, are often affected by surface water, especially in summer. The brine is diluted, averaging 1.2 to 4.5 degrees Baume. No wells are more than 100 meters deep. Some are on sand bars, covered over with river water more than 6 months in the year. The annual output is 876,000 piculs.

Salt from this region is marketed in 13 counties of east Szechwan, and portions of west Hupeh and southeast Shensi. Local streams and the Ch'ang Chiang are used for transport, with some portage. Sales in 1943 were 814,102 piculs.

This region is also largely unexploited, and little is yet known as to its reserves. It has the advantages of easy extraction and processing, abundance of fuel, nearness of potential markets, and easy transportation.

5. Other Minor Regions

The five salt works of Ching-jen, Tzu-chung, Ta-tsu, Yün-lien, and P'eng-shui are combined here for description because they are small, widely scattered, and only locally important. All these wells contain yellow brine, and none is very deep. About 2,000 are clustered in the districts named above. Primitive methods are used; coal is the principal fuel. The five districts produce about 243,000 piculs a year, which is marketed locally.

The entire output for Szechwan in 1943 was 9,433,000 piculs. The prewar annual average was 7 million piculs. During the war production rose. At the outbreak of the war, there was a sudden drop, then a steady rise, due to the large westward migration. Production reached its peak in 1941. Since then, there has been a falling off, due to lack of capital, low ceiling price, and shortage of fuel. The Salt Gabelle has set the annual production quota at more than 9 million piculs, beginning with 1943.

E. Conclusion

Since the war began, the Szechwan salt industry has been very prosperous, because coastal production centers all fell into enemy hands, and consumers had to depend chiefly on supplies from the west. But because of poor management, costs were excessive. While the industry could maintain itself in wartime, yet with communications restored and sea salt sold in the interior, Szechwan salt has found it hard to compete in the national market. Unless a long-term plan of improvement can be put into effect, this industry will decline, with adverse

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results to general livelihood and national revenue. Such a plan of improvement would include the following:

1. Increase of Production

a. Drill new, deeper wells at carefully chosen points. Following surveys in promising areas, trial borings should be undertaken. Present wells should be deepened to tap new strata. Rock salt should be mined by excavation, not by dissolving and drawing out as liquid.

b. Improve technique and equipment for processing. Use modern drilling methods, concentrate to reduce over-all cost, use power-driven machinery, supplement heating by solar evaporation, employ triple-effect vacuum boilers, etc.

2. Enlargement of Market

a. The government authorities should secure suitable distribution, by assigning sales orbits for the various sources of supply, and adjusting excise rates to the cost of production and transport.

b. Expand the use of salt in industry, and make full use of all by-products.

3. Improvement of Transportation

a. Improve the waterways and highways, adding vehicles where needed. Build the projected railways. Mercantile distribution under government supervision will equalize supply and demand.

b. Effect freight economy by arranging return loads of merchandise for each shipment of salt.

4. Enlargment of Fuel Supply

Present available resources are diminishing, new sources must be found and tapped, and instituting new economies in processing must be instituted. Toward those ends:

a. Employ experts to discover and utilize gas reserves, on an intelligent, systematic basis.

b. Increase output of coal mines and secure better transportation.

c. Promote the growth of forests, where wood can be satisfactorily used.

- END -